

UNCLASSIFIED

AD NUMBER

AD474825

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution: Further dissemination only as directed by Army Mobility Command, Attn: AMCPM-GP-MPM, Warren, MI 48090., DEC 1965, or higher DoD authority.

AUTHORITY

CSS memo dtd 22 Mar 2013

THIS PAGE IS UNCLASSIFIED

# **SECURITY**

---

# **MARKING**

**The classified or limited status of this report applies to each page, unless otherwise marked.**

**Separate page printouts MUST be marked accordingly.**

---

**THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 AND 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.**

**NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.**

474825

AD



USATECOM PROJECT NO. 1-6-4030-11

RDT&E PROJECT NO. NOT AVAILABLE

ENGINEER DESIGN TEST  
OF  
TRUCK, UTILITY, 1/4-TON, 4X4, M151  
(RIDE AND HANDLING CHARACTERISTICS)

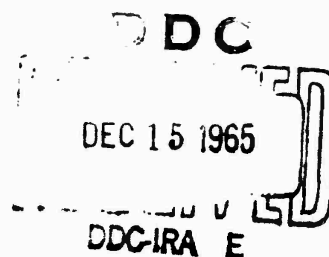
FINAL REPORT

BY

W. S. THOMPSON

DECEMBER 1965

REPORT NO. DPS-1847



ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND

### DDC AVAILABILITY NOTICE

All distribution of this report is controlled. Qualified DDC users shall request through Commanding General, US Army Mobility Command, ATTN: AMCPM-GP-MPM,

### REPRODUCTION LIMITATIONS

Reproduction of this document in whole or in part is prohibited except with the permission of CG, USAMOCOM, ATTN: AMCPM-GP-MPM.

DDC is authorized to reproduce this document for United States Government purposes.

### DISPOSITION INSTRUCTIONS

Destroy this report when it is no longer needed. Do not return it to the originator.

### DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents issued and approved by the Department of the Army.

ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND 21005

ENGINEER DESIGN TEST OF TRUCK,  
UTILITY, 1/4-TON, 4X4, M151 (RIDE AND  
HANDLING CHARACTERISTICS)

RD&E PROJECT NO. NOT AVAILABLE

USATECOM PROJECT NO. 1-6-4030-11

FINAL REPORT

REPORT NO. DPS-1847

PREPARED BY: W. S. THOMPSON

DECEMBER 1965

## TABLE OF CONTENTS

	<u>PAGE</u>
ABSTRACT -----	vi
FOREWORD -----	vi
SECTION 1. GENERAL -----	1
1.1 Objective -----	1
1.2 Responsibilities -----	1
1.3 Description of Materiel -----	1
1.4 Background -----	3
1.5 Findings -----	3
1.6 Conclusions -----	4
1.7 Recommendations -----	4
SECTION 2. DETAILS OF TEST -----	5
2. Introduction -----	5
2.1 Initial Inspection and Preparation -----	5
2.2 Instrumentation -----	5
2.3 Load Distribution -----	6
2.4 Chicane Course Operation -----	8
2.5 Level Cross-Country Operation -----	12
2.6 Hilly Cross-Country Operation -----	14
2.7 Munson Course Operation -----	16
SECTION 3. APPENDICES -----	I-1
Test Data -----	I-1
Correspondence -----	II-1
SECTION 4. DISTRIBUTION LIST	
ABSTRACT CARDS	
DD FORM 1473	

## ABSTRACT

A test was conducted to compare the relative ride and handling characteristics of the standard M151 truck with those of an M151 truck incorporating a solid rear axle with single leaf semielliptical rear springs. The test was conducted from 13 through 26 October 1965. A jury of six drivers performed comparison operations under various vehicle load conditions over specified test courses at Aberdeen Proving Ground, Maryland. Chicane<sup>a</sup> course operation was augmented by instrumentation measuring steering wheel angle, true road speed, road wheel dynamic deflections, and lateral acceleration. After executing severe turning maneuvers on paved surfaces, driver preference was 5 to 1 for the solid-axle-equipped M151 truck; however, after operation on the cross-country courses, driver preference was 6 to 0 for the standard M151 truck. Operation and data show stability of the solid-axle-equipped M151 vehicle to be more easily maintained by virtue of a tendency to slide out on a paved surface, whereas the standard M151 tends to tuck the outer rear wheel under the body. This adversely affects stability in a manner not felt by the operator. On the other hand, the modified M151 truck had poorer ride characteristics on rough surfaces and less control on loose surfaces, thereby offering reduced mobility under tactical conditions.

<sup>a</sup>Chicane is the industry terminology for a steering effort course such as the sine-wave path shown in Appendix I-1.

## FOREWORD

This test was authorized by USATECOM Project Directive, 10 September 1965. Instrumentation data are from Field Engineering Report No. 65-289.

ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 1-6-4030-11

FINAL REPORT OF ENGINEER DESIGN TEST OF TRUCK,  
UTILITY, 1/4-TON, 4X4, M151 (RIDE AND  
HANDLING CHARACTERISTICS)

13 THROUGH 26 OCTOBER 1965

SECTION 1. GENERAL

1.1 OBJECTIVE

This test was conducted to evaluate the ride and handling characteristics of a modified M151 truck equipped with single-leaf semielliptical rear springs and a solid rear axle by comparison with a standard M151 truck.

1.2 RESPONSIBILITIES

Not applicable.

1.3 DESCRIPTION OF MATERIEL

The test vehicle was a production model truck, utility, 1/4-ton, 4X4, M151 which was modified to incorporate a solid rear axle suspended by two single-leaf semielliptical rear springs (Figure 1). Two cross-pin type front shock absorbers were used. These had standard operating lengths and 1/2-inch extended compressed lengths. The front coil springs were nonstandard, having spring rates of 627 pounds per inch (standard spring rate is 513 pounds per inch). The USA registration number of this vehicle is 2E2976 and is identified in this report as the modified vehicle.



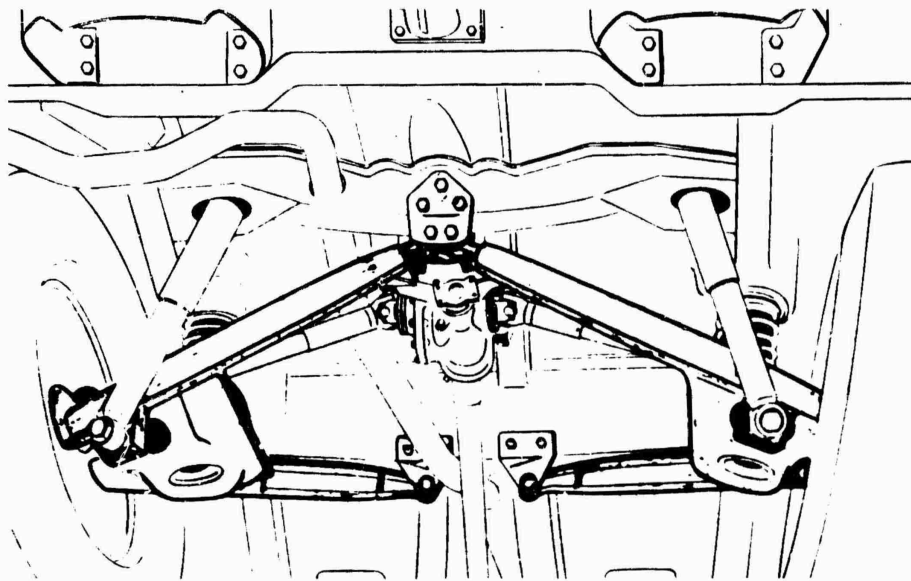


Figure 1: Modified M151 With Solid Rear Axle (View from Rear Looking Forward).

The comparison vehicle was a standard 1/4-ton utility truck, 4X4, M151, with confirmed serviceable shock absorbers and other rear independent suspension components (Figure 2). New tires were installed prior to testing. The USA registration number of this vehicle is 2E9033 and is identified in this report as the standard vehicle.

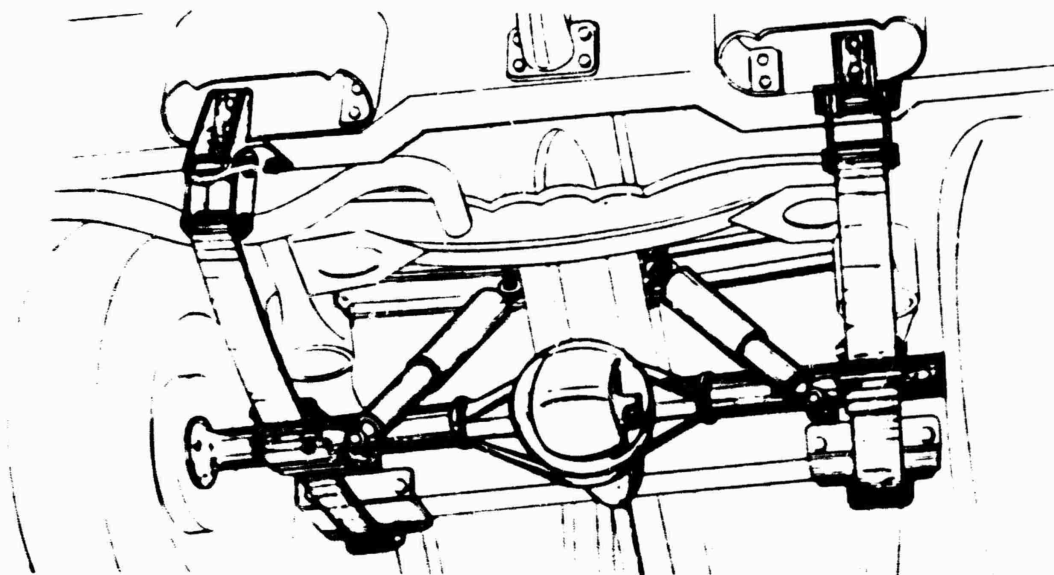


Figure 2: M151, 1/4-Ton (View from Rear Looking Forward).

The test vehicles were outfitted with one set of outrigger struts used alternately on each vehicle during instrumented chicane course operation.

A 1/4-ton, 2-wheeled cargo trailer, M100 was used as a towed load. Empty weight was 560 pounds; cross-country loaded weight was 1560 pounds.

#### 1.4 BACKGROUND

Reports from using activities have indicated the standard M151 independent rear suspension is a suspected cause of traffic accidents involving vehicle roll-over. Investigation proposes that the driver is not aware of approaching instability until he has lost control of the vehicle. An M151 truck was fitted with the more familiar solid rear axle and shipped to Aberdeen Proving Ground for comparison testing with a standard vehicle.

#### 1.5 FINDINGS

When negotiating a turn, the rear outer wheel of the standard M151 truck tends to tuck under the vehicle. The modified M151 truck slides out of the turn.

Rear wheel dynamic deflections during chicane course operation show the standard M151 to lean more in slight turns than the modified M151; however, the jury judged the modified M151 vehicle to lean more in severe turns.

Front wheel dynamic deflections were nearly identical for the two vehicles under like conditions.

The standard M151 truck pitched more when braking.

Steering wheel position data show the standard M151 truck to require less steering wheel displacement and correcting motion; the jury consistently verified this comparison.

Without payload or towed load, ride quality of the standard M151 truck was judged superior to that of the modified M151. With payload and towed load, ride qualities of the two vehicles were nearly equal.

Maximum safe speeds of the modified M151 truck in cross-country operation were slightly lower than those of the standard M151. Limiting factors for the modified vehicle were driver discomfort on rough surfaces and less control with slide-out on soft surfaces.

Maximum safe speed of the modified M151 truck in severe turns on paved surfaces was 2 to 3 mph greater than that obtained from the

standard M151. While both experienced rear inner wheel lift-off, the tuck-under tendency was the limiting factor for the standard vehicle.

Over-all driver preference after chicane course operation was 5 to 1 for the solid-axle-equipped M151 truck; however, after cross-country operation, preference was 6 to 0 for the standard M151.

## 1.6 CONCLUSIONS

Based on the results of this test it is concluded that:

- a. Either vehicle can be overturned unless driver familiarization and good sense are applied. Each is capable of speeds at which vehicle roll-over can occur.
- b. The steering of the standard M151 truck is subject to the effect of outer rear wheel tuck-under which acts to abruptly modify steering effect adversely without immediate awareness by the driver. The magnitude of this effect occurs at the peak of the turn but is commensurate with the speed at time of entry and usually cannot be adequately neutralized by the time stability limits are exceeded (ref par. 2.4.4).
- c. The slide-out tendency of the solid rear axle can be an aid in maintaining stability on paved roads but it produces a greater tendency to slide off a soft road surface, thus detracting from over-all speed and mobility of the M151 truck in cross-country environment (ref pars. 2.6.4 and 2.7.4).
- d. Ride quality on unpaved surfaces is reduced using the solid rear axle; cross-country mobility is thereby reduced in this respect (ref pars. 2.5.4 and 2.7.4).
- e. The rear suspension modification, in the configuration tested, produces no change in resultant front wheel dynamic deflections on paved surfaces (ref Appendix I-2 through I-5).

## 1.7 RECOMMENDATIONS

The solid rear axle configuration should be incorporated in the 1/4-ton utility truck, 4X4, M151 only if highway safety is the predominant mission consideration over tactical mobility, or if tactical mobility of the standard M151 is of a degree which renders some degradation permissible.

## SECTION 2. DETAILS OF TEST

### 2. INTRODUCTION

A 1/4-ton utility truck, 4X4, M151, USA registration No. 2E2976, was received at Aberdeen Proving Ground on 10 September 1965. The vehicle was outfitted with two single-leaf semielliptical rear springs and a solid rear axle for ride and handling evaluation tests. Slight changes in front springs and shock absorbers were included in the modification. The comparison vehicle, a standard M151 truck, registration No. 2E9033, was furnished by APG. Testing was conducted from 13 October through 26 October 1965.

#### 2.1 INITIAL INSPECTION AND PREPARATION

##### 2.1.1 Objective

To assure serviceability of drive train and suspension components.

##### 2.1.2 Method

An inspection was performed on each vehicle for flaws in suspension system components, front wheel alignment, and engine performance.

##### 2.1.3 Results

All suspension components on each vehicle were confirmed serviceable. Minor front wheel alignment adjustments were required on the modified M151 truck. New tires were required on the standard vehicle to assure similarity between vehicles in this respect. Minor tune-up was accomplished on each vehicle.

##### 2.1.4 Analysis

Not applicable.

#### 2.2 INSTRUMENTATION

##### 2.2.1 Objective

To integrate each test vehicle with the required instrument package and a set of anti-roll outrigger struts and wheels.

### 2.2.2 Method

Each vehicle was equipped with instrumentation to measure the following:

- a. Steering wheel angle in degrees (potentiometer).
- b. Lateral acceleration of each corner of the vehicle in g's (linear accelerometer transducers).
- c. Road wheel dynamic deflection, in inches (potentiometers).
- d. True road speed in mph (trailing fifth wheel).
- e. Outrigger contact with road off/on (switches).

The vehicle instrument package was completed with the addition of the multichannel radio link transmitter and antenna.

### 2.2.3 Results

The instrument system was calibrated and operated satisfactorily.

The 250-pound weight of the instrumentation and outrigger assemblies prevented vehicle testing in the empty condition; however, this weight was used as a part of the cross-country payload.

### 2.2.4 Analysis

The instrumentation system used was adequate to produce the data required by the test directive.

## 2.3 LOAD DISTRIBUTION

### 2.3.1 Objective

To determine the load distributions of the vehicles as tested.

### 2.3.2 Method

Loadometer cells were used to determine wheel loadings of each vehicle (excluding driver) at each of the following conditions:

- a. Basic vehicle; no payload, no instrumentation.
- b. Vehicle without payload but with instrumentation and outriggers.
- c. Vehicle with payload; instrumentation and outriggers were part of the cross-country payload.

### 2.3.3 Results

Load distributions of the two vehicles (excluding driver) and of the trailer are shown in Table I.

Table I. Load Distribution

Condition	Wheel Loading, lb				Total
	Right Front	Left Front	Right Rear	Left Rear	
Vehicle: Truck, M151, registration No. 2E9033 (standard).					
Basic vehicle	700	710	540	580	2530
Without payload but with instrumentation and outriggers	710	720	670	680	2780
With payload	710	730	780	810	3030
Vehicle: Truck, M151, registration No. 2E2976 (modified).					
Basic vehicle	670	680	530	560	2440
Without payload but with instrumentation and outriggers	690	680	640	680	2690
With payload	690	690	760	800	2940
Vehicle: Trailer, M100.					
Empty	-	-	-	-	560
With payload	-	-	-	-	1560

### 2.3.4 Analysis

The 250-pound weight of the required instrumentation and outrigger assemblies prevented instrumented testing in the empty condition; however, this weight was used as part of the cross-country payload during

the chicane course operation. All other jury operation was not instrumented and employed standard dead weight payloads when required

## 2.4 CHICANE COURSE OPERATION

### 2.4.1 Objective

To provide jury evaluation of the comparative ride and handling characteristics of the test vehicles with respect to steering maneuvers on a paved level surface. Also, to obtain instrument data to supplement this evaluation.

### 2.4.2 Method

Each of six jury drivers made one northbound and one southbound pass through the chicane course (ref page I-1) at each nominal test speed under each of the following required load conditions:

- a. Vehicle empty (except instruments).
- b. Vehicle empty (except instruments) towing empty trailer.
- c. Vehicle with cross-country payload.
- d. Vehicle with cross-country payload; with 1500-pound gross towed load.

Data were transmitted from the test vehicle via a multichannel radio link telemetry system to a recording van where it was recorded on magnetic tape. Subsequently, all data were transcribed from the tape through a recording oscillograph onto oscillograms for data reduction.

Planned test speeds were 15 mph, 20 mph, and maximum; however, 20 mph was maximum for the standard M151 truck.

Each driver answered the questionnaire (ref page I-12) once for each load condition, a total of four times during this test phase.

### 2.4.3 Results

The data presented in this report illustrate vehicle characteristics as each negotiated the 25-foot-radius curve shown on page I-1. The values are arithmetical averages of the results obtained from individual drivers.

There was no appreciable difference between vehicles in the relative dynamic deflection characteristics of the front wheels. Maximum deflections ranged from approximately 1 inch in jounce to 2 to 3 inches in rebound. In this report, wheel deflection toward the body will be termed jounce; wheel deflection away from the body will be termed rebound. Front wheel characteristics are presented on pages I-2 through I-5.

Relative rear wheel reactions differed considerably between vehicles. The inner rear wheel of each vehicle lifted, but the deflection magnitudes produced in the standard rear suspension were consistently greater than those of the modified suspension - nearly twice as much rebound at 15 mph and as high as 4 times as much at 20 mph. (Ref pages I-2 through I-5; upper quadrants of the rear wheel characteristic curves.)

The primary difference in turning behavior occurred at the outer rear wheel of each vehicle. The modified vehicle leaned at a rate that was nearly proportionate to the speed of entry into the turn. With increased speed, the modified M151 truck slid considerably and thereby understeered; in the 21-mph range, slight inner rear wheel lift-off occurred.

Behavior of the standard M151 truck through this turn was similar to that of the modified M151 at speeds up to 17 mph, except for the greater lean shown by the data. At speeds above 17 mph, characteristics differed greatly. As the standard M151 truck entered the test turn, the outer rear wheel developed 1-1/2 inches of jounce. Then, as the vehicle progressed into the turn, the direction of outer rear wheel deflection reversed into rebound until the wheel began to tuck under the body. At the same time, the inner rear wheel was also in rebound position, resulting in rear end lift of about 2 inches or more at 20 mph. Slide-out ranged from undetectable to minimal. Further, from the data it was noted that additional lean developed at a lower rate from the moment when the outer rear wheel deflection reversed and tuck-under began until instability was reached. Characteristic curves for the outer rear wheel deflections on this vehicle (pages I-2 through I-5) illustrate this behavior by the use of two points, A and B, corresponding to 20 mph. Point A represents the maximum jounce deflection at this wheel while the vehicle leaned into the turn. Point B represents the maximum rebound deflection at the same wheel, attained momentarily later as the wheel tucked under the body. Page I-9 shows traces for a sample run. Right rear wheel movement illustrates tuck-under. Right rear wheel movement illustrates initial lean followed abruptly by reversal into tuck-under.

In most cases, the modified M151 truck required more steering effort (ref pages I-10 and I-11).



No significant differences were noted in the lateral accelerations experienced by each vehicle in this phase. Side thrusts were about the same under each condition; maximum g loadings at the nominal 20 mph speed ranged from 0.7 to 1.1 g's. Lateral accelerations and supplementary data are summarized on pages I-6 and I-7.

Additional road wheel deflections produced by the modified M151 at maximum speed in the 25-foot radius turn are summarized on page I-8.

Jury evaluation of this phase of testing is tabulated on page I-13.

#### 2.4.4 Analysis

The differences in handling and stability characteristics of the two vehicles stem almost entirely from outer rear wheel behavior; i.e. in turns, the modified M151 truck tends to slide out and the standard M151 tends toward outer rear wheel tuck-under.

The two vehicles enter a turn similarly. Each begins to lean at a rate easily sensed by the driver; forces felt by the driver of each vehicle are about the same at this point. If the turning maneuver is of sufficient severity, outer rear wheel tuck-under begins with reversal in the direction of displacement at this wheel. At this point in the turn, the threshold of instability is approaching and the driver cannot detect it. From here on, the reduced lean rate produces false confidence; rear end lift and the absence of sliding tend to make the vehicle feel sure-footed. In actuality, outer rear wheel tuck-under is closing the distance through which the center of gravity of the vehicle must travel before turn-over occurs. Also, the rising rear end further impairs stability by raising the center of gravity higher above the road. This provides the upset forces and more leverage about the points of road contact.

On the other hand, the modified M151 vehicle simply remains in a leaning attitude, sliding if necessary, to continue negotiating the turn. The driver gages the amount of lean as a measure of stability. He also feels and hears the sliding action and immediately recognizes it as a symptom of approaching instability.

These conditions prevailed in testing under the first three load conditions. Neither the cross-country payload nor the empty trailer altered the comparison significantly. With the addition of a loaded trailer, some changes were noted. It was found that the 1500-pound gross towed load increased slide-out tendencies of the modified M151 truck and reduced maximum speed through the 25-foot radius turn to 20 mph, whereas the load exerted on the pintle of the standard M151 retarded the tuck-under action and produced enough slide-out to serve as an indication of approaching instability.

Perhaps of even more import, is the modifying effect on steering produced by the outer rear wheel when it tucks under the body. The characteristic is sharply defined in the steering wheel position characteristic curves in pages I-10 and I-11. As tuck-under occurs, the outer rear wheel has the effect of steering the rear end around the turn and aiding over-all steering effort.

The curves tend to illustrate this aspect as little additional steering wheel angle is required for the standard M151 truck to negotiate the 25-foot turn at speeds above 15 to 16 mph (the speed at which tuck-under began to appear in this test turn). On occasion, less steering wheel angle was measured at 20 mph than at 15 mph for this vehicle; however, the modified M151 truck required more steering effort with increased turning speed. In the standard M151 vehicle, the relative difference in steering effort was supplied by the outer rear wheel. This causes maneuvering of the vehicle to be easier until the limits of stability are exceeded, and then it causes upsetting of the vehicle to be easier. Just before upset, this steering assistance opposes corrective steering effort and cannot be regulated in time since it is produced as a function of speed, and as such, was reasonably predetermined when the vehicle entered the turn.

The modified M151 truck appeared to offer a safety valve effect in that the inner rear wheel tended to lift and lose traction thereby helping to prevent further forward momentum at a critical moment. The greater range of movement in the inner rear wheel of the standard M151 truck allows it to reach down for the road and to continue driving the vehicle a little longer when approaching instability.

The jury consensus was as follows:

- a. Both vehicles leaned about the same amount in turns. They were unable to detect the differences shown by the instrument data.
- b. The standard M151 truck required less wheel turning. Resolution of the instrument data generally confirmed this, but showed considerable variations between individual drivers.
- c. The majority of the jury voted for the modified M151 truck as producing a greater sense of confidence and control. Those voting for the standard M151 vehicle tempered their decision by adding that it may have been a false sense of confidence.
- d. The highway ride quality of the standard M151 truck is slightly superior on paved surfaces.
- e. The jury preferred driving the modified M151 truck by as high a margin as 5 to 1 during the maneuvering test phase.

## 2.5 LEVEL CROSS-COUNTRY OPERATION

### 2.5.1 Objective

To provide jury evaluation of the comparative ride and handling characteristics of the test vehicles operating on level cross-country roads.

### 2.5.2 Method

Each of six jury drivers operated each vehicle for at least one cycle on the 5-mile-long No. 1 cross-country course at Perryman Test Area, under each of the following load conditions:

- a. Vehicle empty.
- b. Vehicle empty, towing empty trailer.
- c. Vehicle with cross-country payload.
- d. Vehicle with cross-country payload with 1500-pound gross towed load.

The test course was level and included both sharp and sweeping curves. The road surface consisted primarily of quarry spall and bank gravel characterized by pot holes, washboarding, and rutting, up to 6 inches deep, throughout the length of the course. Weather was dry at all times.

Each driver answered the questionnaire once for each load condition, a total of four times during this test phase.

### 2.5.3 Results

Jury voting results are tabulated in Appendix I-14.

Average speeds attained on this course are shown in Table II.

Table II. Road Speeds, Cross-Country Operation

Load Condition	Average Speed, mph			
	Individual Driver		Over-All	
	Modified M151	Standard M151	Modified M151	Standard M151
Empty	18.5 to 20.3	19.0 to 22.3	19.50	19.90
Empty, with empty trailer	19.5 to 20.6	20.3 to 24.6	20.00	21.38
Loaded	22.4 to 29.0	21.9 to 28.3	24.60	24.44
Loaded, with load- ed trailer	20.0 to 24.5	20.9 to 23.9	22.52	22.90

#### 2.5.4 Analysis

The principal feature evaluated on this course was ride quality and its effect on cross-country mobility. The solid axle definitely compromises the M151 vehicle ride quality in the empty load condition. This slightly reduces attainable speeds due to driver discomfort. Personnel discomfort actually contrasts substantially more than the average speeds would indicate. As a bump is encountered by one side of the modified M151 truck, shock is transmitted heavily to personnel on the other side, whereas the independent suspension of the standard M151 tends to substantially isolate the shock.

In the loaded conditions, comparative ride qualities approach equality. That is, the weight has the effect of smoothing out the bumps, but the transmissibility feature tends to increase the apparent number of bumps sustained by the modified vehicle.

The jury felt that the standard M151 vehicle required more steering control while braking in the empty conditions, but with the addition of load, the modified M151 required more such control. The differences in this respect were not greatly significant.

As in the previous test phase, the jury felt that the modified M151 truck leaned more in turns. This is disputed by instrument data, hence this opinion is questionable, and may be a result of the seat of the pants aspect of the solid axle suspension.

Driver preference and the greater feeling of confidence during this test phase were awarded to the standard M151 truck, principally due to the relatively superior ride quality.

## 2.6 HILLY CROSS-COUNTRY OPERATION

### 2.6.1 Objective

To provide jury evaluation of the comparative ride and handling characteristics of the test vehicles operating on hilly cross-country roads.

### 2.6.2 Method

Each of six jury drivers operated each vehicle for at least one cycle on the 3.8-mile-long hilly cross-country course at Churchville Test Area, under each of the following load conditions:

- a. Vehicle empty.
- b. Vehicle empty, towing empty trailer.
- c. Vehicle with cross-country payload.
- d. Vehicle with cross-country payload, with 1500-pound gross towed load.

The test course was composed of soil and stone roadbed with grades up to 27%, some washboarding, and scattered surface looseness. Weather was dry at all times.

Each driver answered the questionnaire once for each load condition, a total of four times during this test phase.

### 2.6.3 Results

Jury voting results are tabulated in Appendix I-15.

Average speeds attained on this course were as shown in Table III.

Table III. Road Speeds, Hilly Cross-Country Operation

Load Condition	Average Speed, mph			
	Individual Driver		Over-All	
	Modified M151	Standard M151	Modified M151	Standard M151
Empty	27.3 to 30.9	28.7 to 32.0	28.90	30.50
Empty, with empty trailer	26.2 to 29.5	27.0 to 30.8	27.27	28.05

Table III (Cont'd)

Load Condition	Average Speed, mph			
	Individual Driver		Over-All	
	Modified M151	Standard M151	Modified M151	Standard M151
Loaded	29.0 to 33.6	28.7 to 33.5	30.63	30.73
Loaded, with loaded trailer	25.5 to 28.7	25.3 to 29.3	26.92	27.50

#### 2.6.4 Analysis

The standard M151 truck attained higher speeds through this course under all loading conditions. In analyzing this test phase, one additional factor must be considered - that of delivered horsepower. The standard M151 truck had been operated 33,000 miles and, while the history of the engine is not known, slightly less power was available in climbing hills despite tuneup efforts. It is estimated that the relative differences in attained average speeds in the loaded conditions would have been about 1 mph greater without this condition.

The modified M151 truck has a greater tendency to slide out of fast turns when loose surfaces are encountered. This is caused by the rigid nature of the solid axle rear suspension tending to push the front end out of the turn. This often necessitated downshifting when entering curves, which results in a trade-off of speed for additional control. One side of the modified vehicle did leave the road slightly on more than one occasion without mishap. Presence of the trailer greatly increased this tendency.

In comparison, the flexibility of the standard independent rear suspension allows the rear wheels to reach down into a soft surface, enhancing traction and lateral stability as long as limitations are not exceeded.

The jury decided that the modified vehicle leaned more in turns and that the standard vehicle produced a better feeling of confidence and control in this environment. This is thought to be the results of the presence of some degree of outer rear wheel tuck-under; however, this effect is less pronounced on this type of road than on paved surfaces.

Voting on the issue of steering control while braking gave little information because of intermittent brake grabbing on each vehicle.

Ride quality of the standard vehicle is not as decidedly superior on this course due to the less severe surface condition. Under loaded conditions, superiority of ride in this vehicle could be described as very slight.

The jury unanimously preferred the standard M151 truck on this course.

## 2.7 MUNSON COURSE OPERATION

### 2.7.1 Objective

To provide jury evaluation of the comparative ride and handling characteristics of the test vehicles operating on gravel and Belgian block courses.

### 2.7.2 Method

Each of six jury drivers operated each vehicle for at least one cycle on the gravel road (10,840 feet long) and Belgian block section (3934 feet long) of the Munson Test Area, under each of the following load conditions:

- a. Vehicle empty.
- b. Vehicle empty, towing empty trailer.
- c. Vehicle with cross-country payload.
- d. Vehicle with cross-country payload, with 1500-pound gross towed load.

The gravel test course is composed of graded compacted gravel; the Belgian block course is paved with unevenly laid granite blocks forming an undulating surface. Weather was dry at all times.

Each driver answered the questionnaire once for each load condition, a total of four times during this test phase.

### 2.7.3 Results

Jury voting results are tabulated in Appendix I-16.

A nominal target speed of 20 mph was established for Belgian block operation. Average speeds were not recorded due to the presence of smooth paved road in this loop which caused large and misleading deviations in resultant averages.

Average speeds attained on the gravel course were as shown in Table IV.

Table IV. Road Speeds, Munson Course Operation

Load Condition	Average Speed, mph			
	Individual Driver		Over-All	
	Modified M151	Standard M151	Modified M151	Standard M151
Empty	31.4 to 32.4	31.4 to 32.5	31.80	32.65
Empty, with empty trailer	31.1 to 34.0	31.8 to 32.8	32.83	32.32
Loaded	28.9 to 38.0	31.8 to 41.0	32.85	34.92
Loaded, with loaded trailer	28.6 to 36.7	29.3 to 34.3	31.48	31.13

#### 2.7.4 Analysis

Ride quality of the standard vehicle was decidedly superior on Belgian block; this superiority was less pronounced on gravel. In loaded conditions, each vehicle was nearly equal in this respect on Belgian block and completely equal on gravel.

Stability was not a factor in Belgian block operation. On gravel, the modified M151 truck exhibited noticeably greater slide tendencies but the standard M151 lost some preference votes when its rear wheels tended to stick in road ruts and thus hamper control slightly.

Driver preference in this phase was the standard M151 truck. Principal reasons appear to be the lesser wheel turning requirement and the better ride quality of the standard M151 vehicle, as opposed to the sliding tendencies of the modified M151.



SECTION 3. APPENDICES

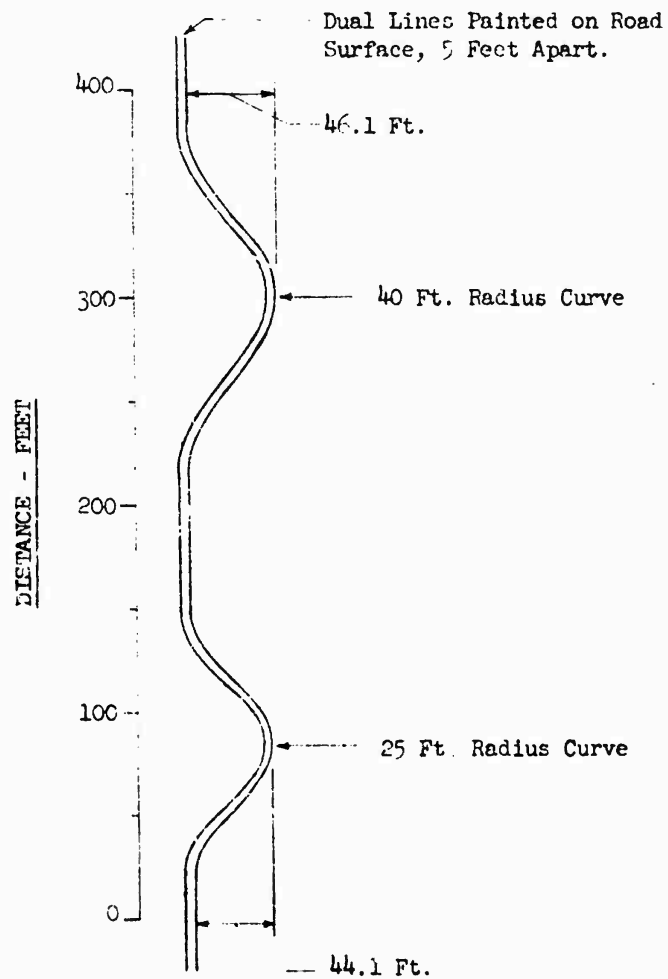
APPENDIX I - TEST DATA

TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NO. 2E9033 & 2E2976

SKETCH OF COURSE UTILIZED FOR INSTRUMENTED VEHICLE  
HANDLING CHARACTERISTIC TESTS

Surface: Level, Paved

Dates of Test: 15 - 17 October 1965

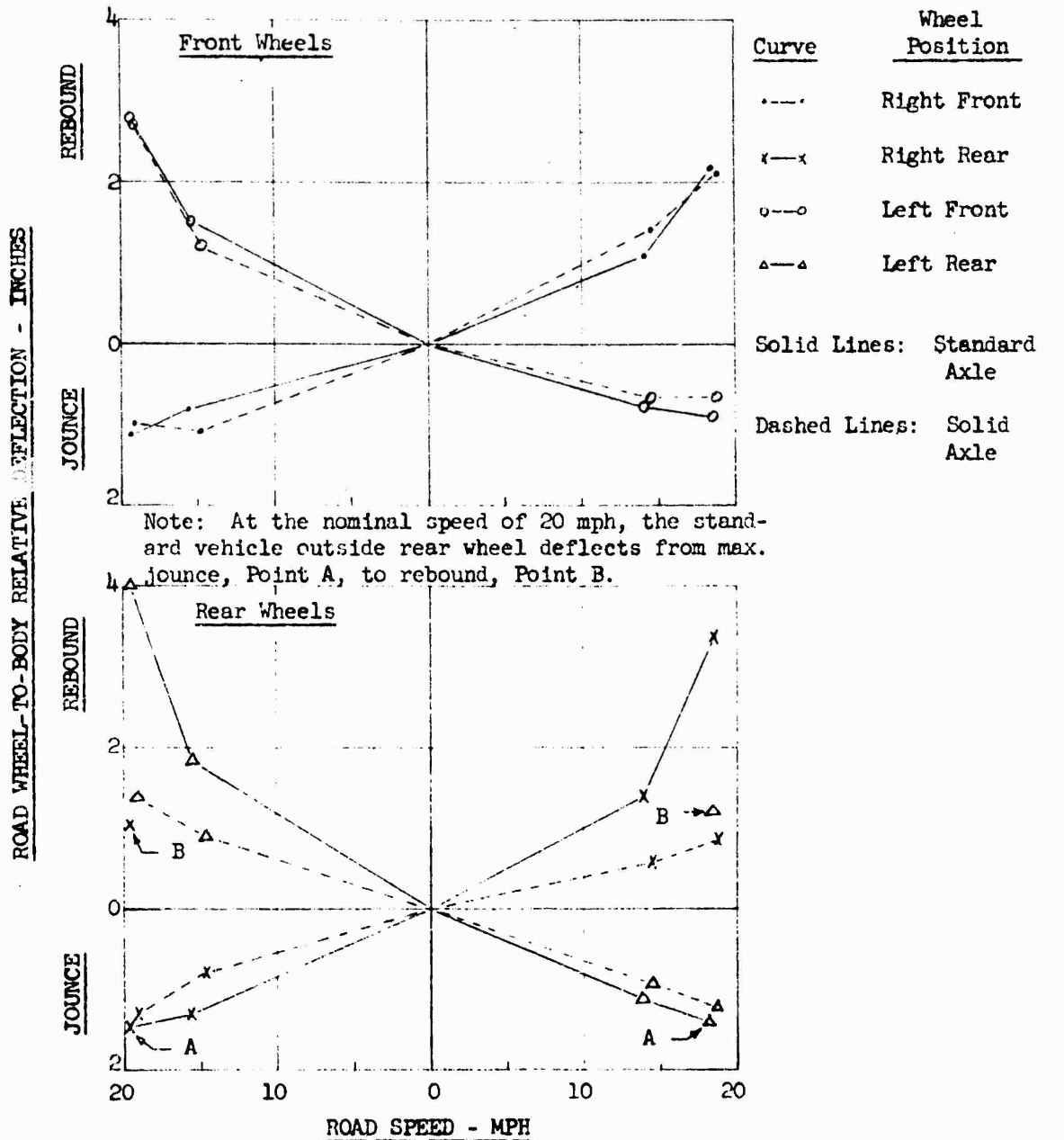


TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NOS. 2E9033 & 2E2976

ROAD WHEEL-TO-BODY RELATIVE DEFLECTION WHILE CORNERING 25 FT  
RADIUS CURVE AT STEADY SPEED - COMPARISON OF STANDARD AXLE  
(VEHICLE NO. 2E9033) AND SOLID AXLE (VEHICLE NO. 2E2976)

Test Condition: Vehicle W/O Payload; Weight (Excluding Driver)  
2780 Lb - Vehicle No. 2E9033  
2690 Lb - Vehicle No. 2E2976  
W/O Towed Load

Dates of Test: 15-17 October 1965



370 371 Left Turn Right Turn 328 333  
408 370 336 367

Steering Wheel Angle - Degrees

Vehicle No. 2E9033  
Vehicle No. 2E2976

Engr & Environmental Test Br  
Development & Proof Services  
Aberdeen Proving Ground, Md.  
RLambert/skc/3 November 1965

TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NOS. 2E9033 & 2E2976

ROAD WHEEL-TO-BODY RELATIVE DEFLECTION WHILE CORNERING A 25 FT  
RADIUS CURVE AT STEADY SPEED - COMPARISON OF STANDARD AXLE  
(VEHICLE NO. 2E9033) AND SOLID AXLE (VEHICLE NO. 2E2976)

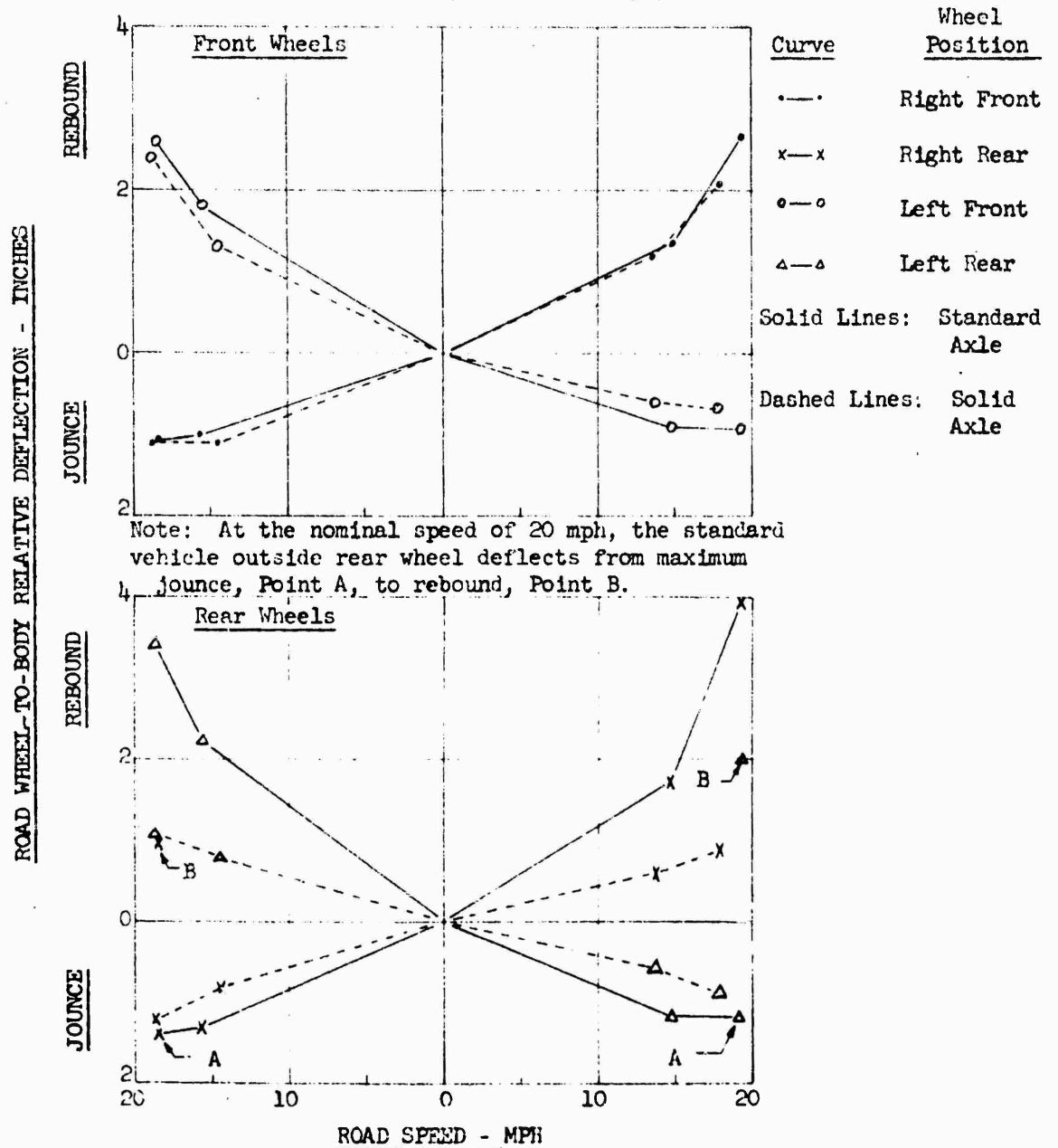
Test Condition: Vehicle W/O Payload; Weight (Excluding Driver)

2780 Lb - Vehicle No. 2E9033

2690 Lb - Vehicle No. 2E2976

W/500 Lb Towed Load

Dates of test: 15-17 October 1965



324	335	Left Turn	Right Turn	324	333	← Vehicle No. 2E9033
365	332			280	310	

Steering Wheel Angle - Degrees

Engr & Environmental Test Br  
Development & Proof Services  
Aberdeen Proving Ground, Md.  
RLambert/skc/3 November 1965

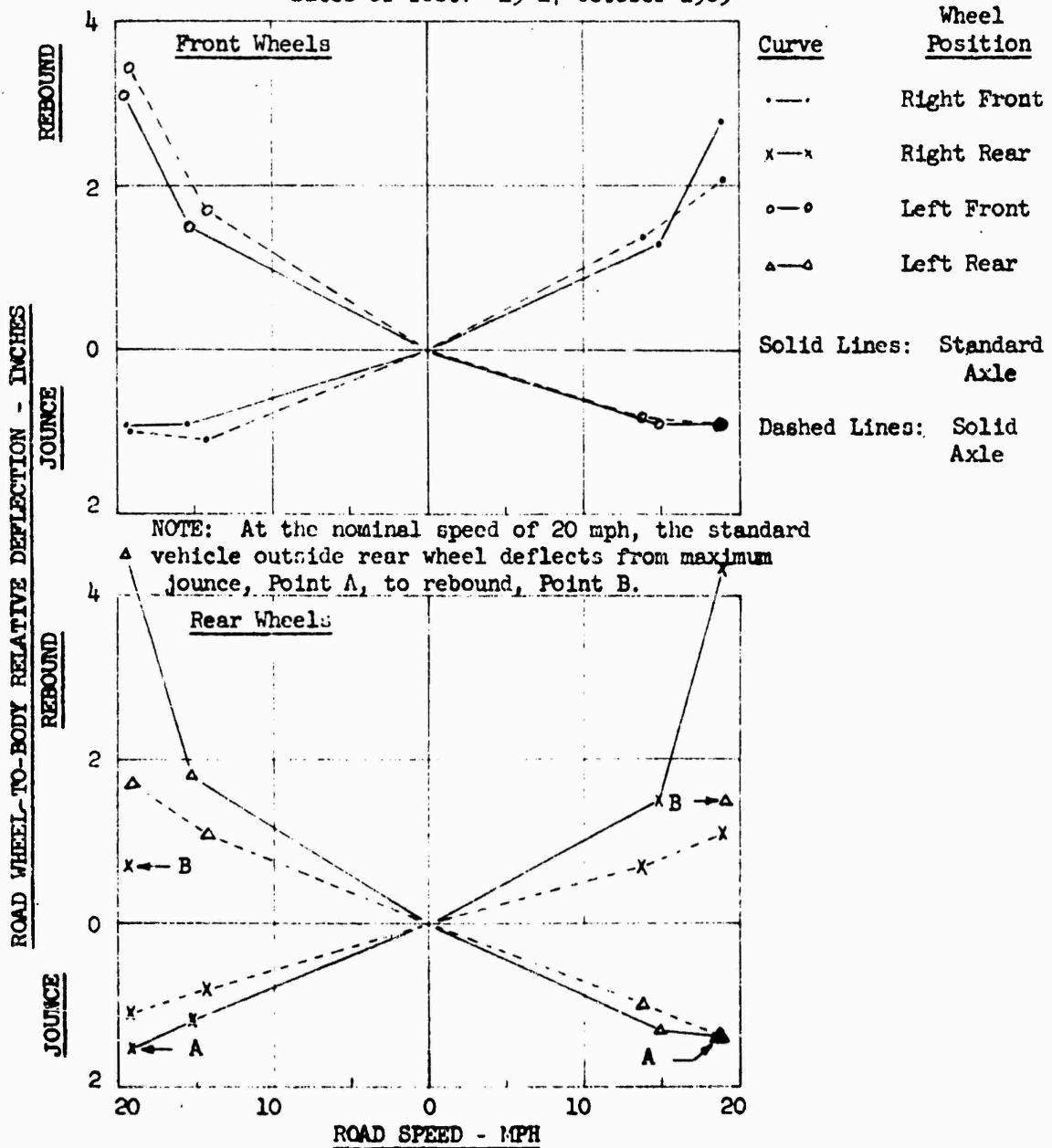
TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NOS. 2E9033 & 2E2976

ROAD WHEEL-TO-BODY RELATIVE DEFLECTION WHILE CORNERING A 25 FT  
RADIUS CURVE AT STEADY SPEED - COMPARISON OF STANDARD AXLE  
(VEHICLE NO. 2E9033) AND SOLID AXLE (VEHICLE NO. 2E2976)

Test Condition: Vehicle W/Payload; Weight (Excluding Driver)  
3030 Lb - Vehicle No. 2E9033  
2940 Lb - Vehicle No. 2E2976

W/O Towed Load

Dates of Test: 15-17 October 1965



423	398	Left Turn	Right Turn	387	363	← Vehicle No. 2E9033
477	466			373	455	

Steering Wheel Angle - Degrees

Eng & Environmental Test Br  
Development & Proof Services  
Aberdeen Proving Ground, Md.  
RLambert/skc/3 November 1965

TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NO. 2E9033 & 2E2976

ROAD WHEEL-TO-BODY RELATIVE DEFLECTION WHILE CORNERING A 25 FT  
RADIUS CURVE AT STEADY SPEED - COMPARISON OF STANDARD AXLE  
(VEHICLE NO. 2E9033) AND SOLID AXLE (VEHICLE NO. 2E2976)

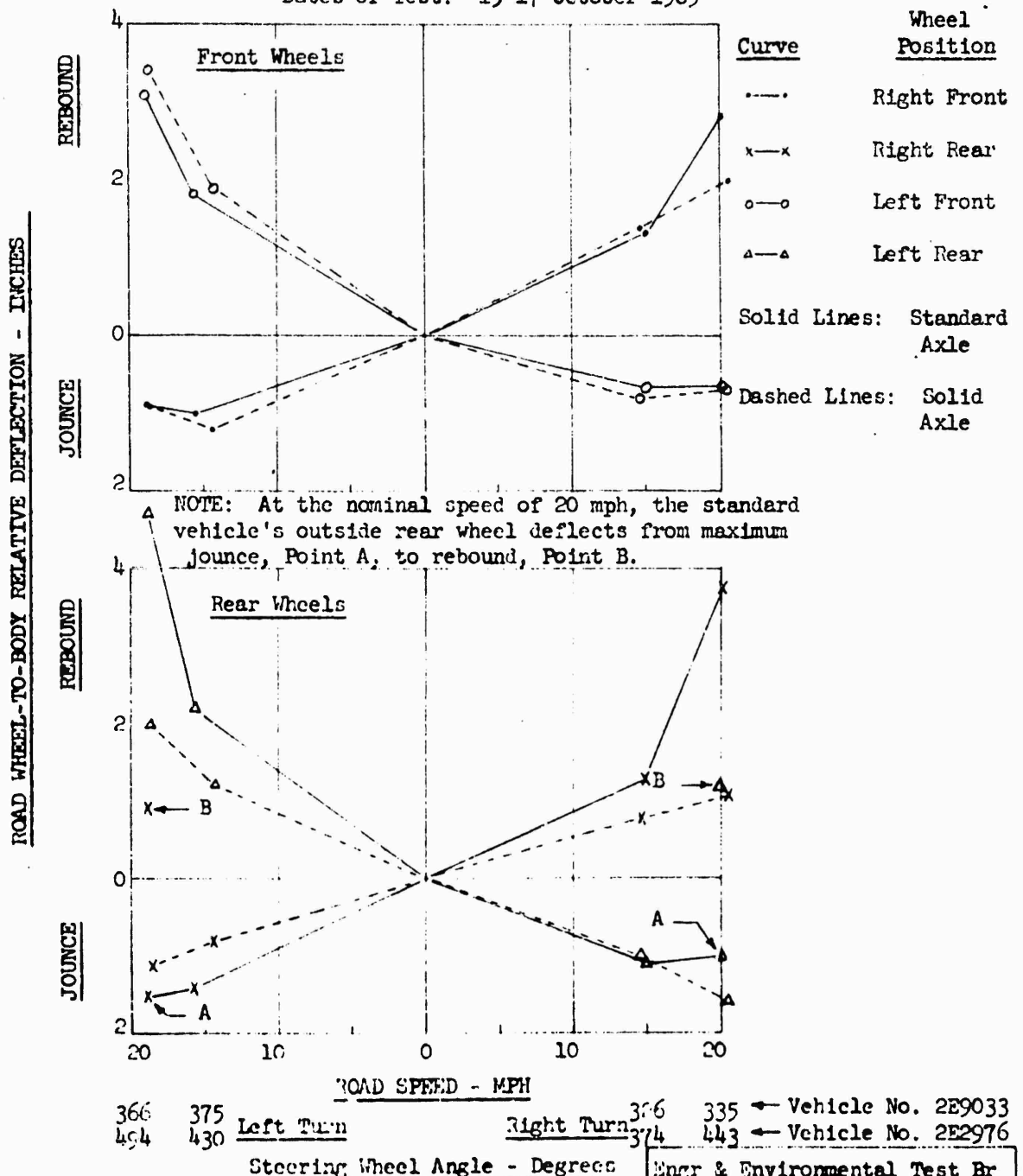
Test Condition: Vehicle W/Payload; Weight (Excluding Driver)

3030 Lb - Vehicle No. 2E9033

2940 Lb - Vehicle No. 2E2976

W/1500 Lb Towed Load

Dates of Test: 15-17 October 1965



Engr & Environmental Test Br  
Development & Proof Services  
Aberdeen Proving Ground, Md.  
RLambert/skc/3 November 1965

TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NO. 2E9033 (STANDARD REAR AXLE)

SUMMARY DATA - LATERAL ACCELERATION RECORDED AT EACH CORNER OF THE  
VEHICLE WHILE CORNERING A 25-FT RADIUS CURVE

Vehicle Weight: (Excluding Driver)  
2780 Lb - W/O Payload  
3030 Lb - W/Payload  
Dates of Test: 15 - 17 October 1965

Test Condition	Direction of Turn	Road Speed Mph	Lateral Acceleration - g			
			Right Front	Right Rear	Left Front	Left Rear
W/O Payload W/O Towed Load	Right	14.0	0.4	0.4	0.6	0.6
		18.5	0.6	0.8	0.9	0.9
	Left	15.5	0.6	0.6	0.6	0.6
		19.5	0.9	0.9	0.8	1.0
W/O Payload W/500 Lb Towed Load	Right	14.9	0.5	-	0.6	0.6
		19.4	0.7	-	0.9	0.9
	Left	15.6	0.7	-	0.6	0.7
		18.5	0.9	0.9	0.7	0.9
W/Payload W/O Towed Load	Right	14.9	0.5	0.5	0.6	0.7
		19.0	0.7	0.7	0.9	1.0
	Left	15.3	0.7	0.7	0.7	0.6
		19.4	0.9	1.0	0.8	0.9
W/Payload W/1500 Lb Towed Load	Right	14.9	0.4	0.4	0.5	0.7
		20.1	0.6	0.7	0.8	0.9
	Left	15.7	0.7	0.7	0.8	0.7
		18.9	0.9	0.9	0.9	0.9

TRUCK, UTILITY, 1/4 TON, 4X4, M151, USA REG. NO. 2E2976 (MODIFIED REAR AXLE)

SUMMARY DATA - LATERAL ACCELERATION RECORDED AT EACH CORNER OF THE  
VEHICLE WHILE CORNERING A 25-FT RADIUS CURVE

Vehicle Weight: (Excluding Driver)  
2690 Lb - W/O Payload  
2940 Lb - W/Payload

Dates of Test: 15-17 October 1965

Test Condition	Direction of Turn	Road Speed Mph	Lateral Acceleration - g			
			Right Front	Right Rear	Left Front	Left Rear
W/O Payload	Right	14.6	0.5	0.5	0.6	0.6
W/O Towed Load		18.9	0.7	0.7	0.9	1.0
		20.1	0.7	0.7	1.0	1.0
	Left	14.7	0.6	0.6	0.6	0.7
		19.1	0.9	0.9	0.8	0.9
		20.5	1.0	1.0	0.9	0.9
W/O Payload	Right	13.7	0.4	0.4	0.5	0.5
W/500 Lb		17.8	0.6	0.7	0.8	0.8
Towed Load		20.8	0.8	0.8	0.8	0.8
	Left	14.6	0.6	0.6	0.5	0.5
		18.8	0.8	0.9	0.7	0.8
		19.6	0.9	1.0	0.7	0.8
W/Payload	Right	13.8	0.4	0.4	0.7	0.7
W/O Towed Load		19.0	0.7	0.7	1.1	1.2
		23.3	0.8	0.7	1.2	1.3
	Left	14.3	0.7	0.6	0.7	0.7
		19.2	0.9	0.9	0.9	1.1
		20.5	1.0	1.0	1.0	1.1
W/Payload	Right	14.6	0.5	0.4	0.7	0.7
W/1500 Lb		20.6	0.7	0.7	1.1	1.1
Towed Load						
	Left	14.4	0.6	0.6	0.7	0.7
		18.6	0.9	0.9	0.9	1.0

TRUCK, UTILITY, 1/4 TON, 4x4, M151, USA REG. NO. 2E2976

(MODIFIED REAR AXLE)

SUMMARY DATA - STEERING WHEEL AND ROAD WHEEL DEFLECTIONS WHILE  
CORNERING A 25-FT RADIUS CURVE

Vehicle Weight: (Excluding Driver)  
2690 Lb - W/O Payload  
2940 Lb - W/Payload

Dates of Test: 15 - 17 October 1965

<u>Test Condition</u>	<u>Direction of Turn</u>	<u>Road Speed Mph</u>	<u>Steering Wheel Angle Degrees</u>	<u>Wheel Deflection - Inches *</u>			
				<u>Right Front</u>	<u>Right Rear</u>	<u>Left Front</u>	<u>Left Rear</u>
W/O Payload W/O Towed Load	Right	20.1	370	2.2	1.1	-3.8	-1.5
	Left	20.5	466	-1.2	-1.4	2.7	1.5
W/O Payload W/500 Lb Towed load	Right	20.8	254	2.2	0.9	-0.9	-1.1
	Left	19.6	374	-1.2	-1.2	2.6	1.2
W/Payload W/O Towed load	Right	23.3	475	2.1	1.2	-1.0	-1.8
	Left	20.5	511	-0.9	-1.2	3.5	1.8

\* Positive values denote wheel deflection as rebound; negative values denote it as jounce.



TRUCKS, UTILITY, 1/4 TON, 4X4, M151, USA REG. NO. 2E9033 & 2E2976

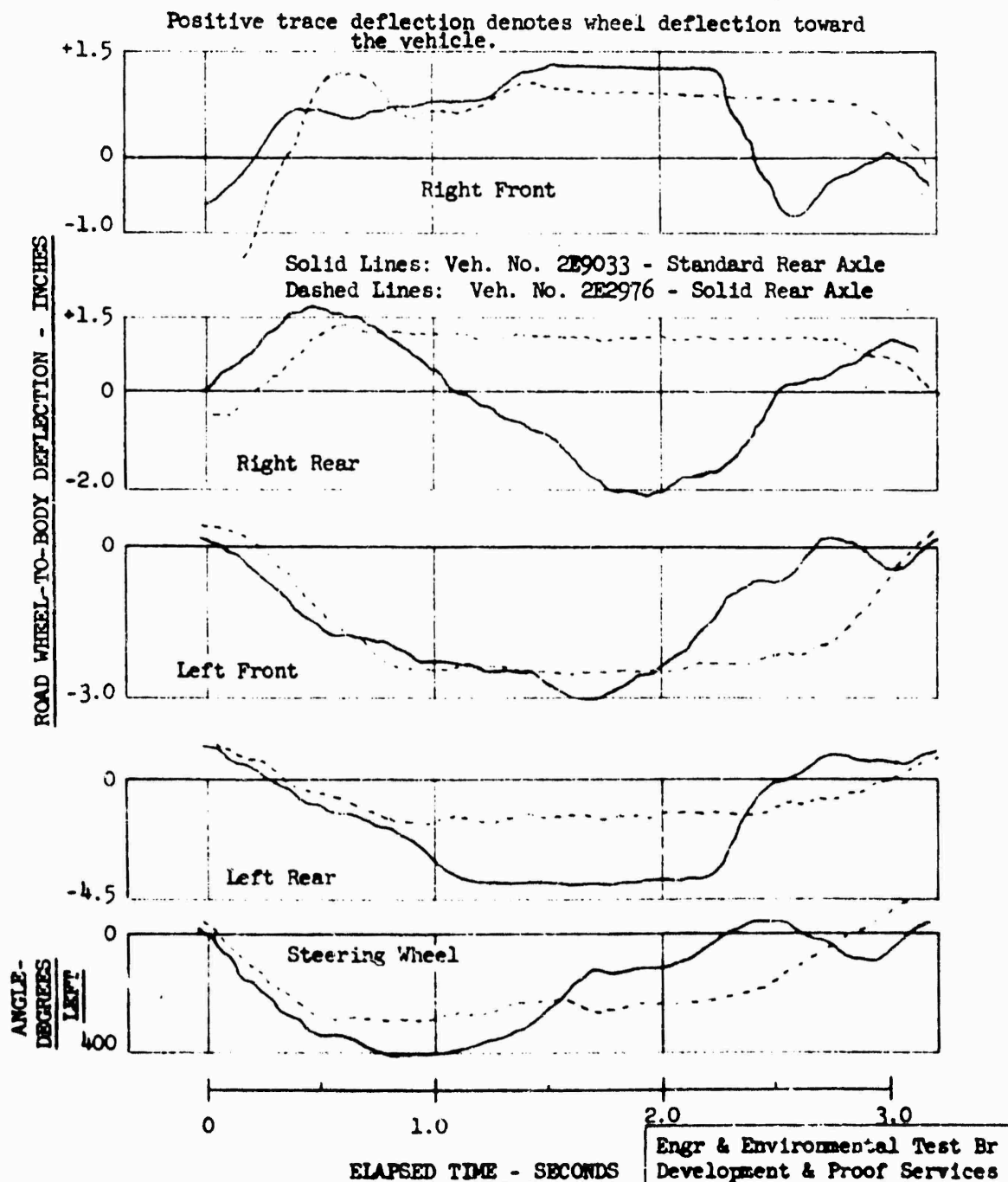
TRACINGS FROM OSCILLOGRAMS - SHOWING RELATIVE WHEEL DEFLECTIONS WHILE  
CORNERING A 25-FT RADIUS CURVE

Test Condition: Vehicles W/O Payload, W/O Towed Load

Average Speed: 19.7 Mph

Dates of Test: 15 - 17 October 1965

Direction of Turn: Left



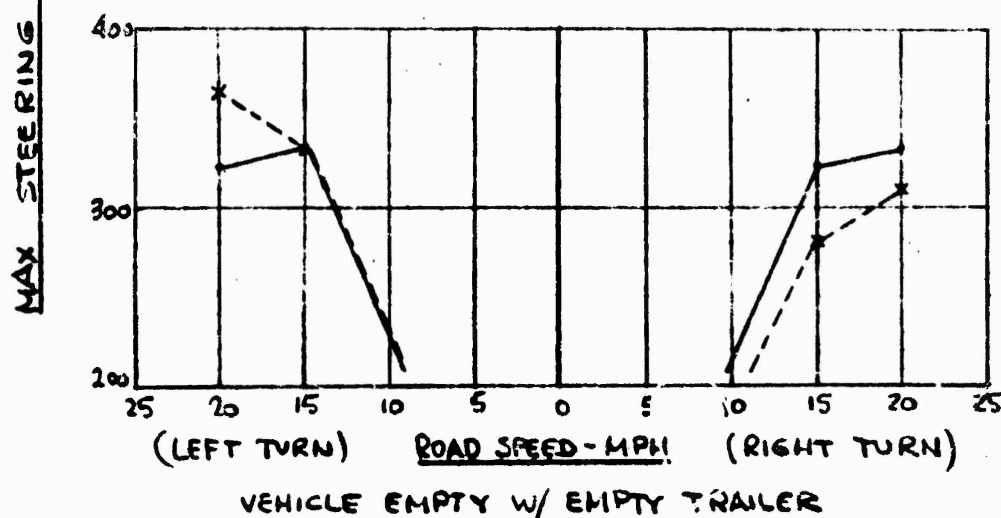
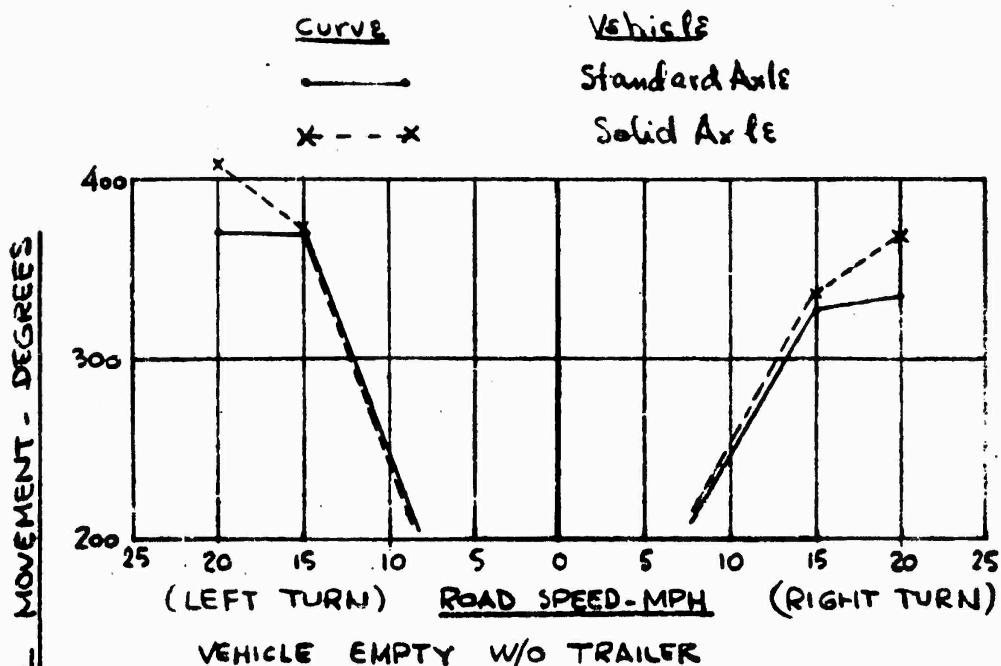
Engr & Environmental Test Br  
Development & Proof Services  
Aberdeen Proving Ground, Md.  
RLambert/skc/8 November 1965

TRUCK, UTILITY: 1/4 TON, 4x4, M151, USA REG NO. 2E9033 & 2E2976

CURVES OF MAXIMUM STEERING WHEEL MOVEMENT WHILE  
CORNERING A 25 FT RADIUS CURVE AT STEADY SPEED -  
COMPARISON OF STANDARD AXLE (VEHICLE NO. 2E9033)  
AND SOLID AXLE (VEHICLE NO. 2E2976)

Test Conditions: Vehicles Empty; w/ & w/o Empty Trailer

Dates of Test: 15-17 October 1965



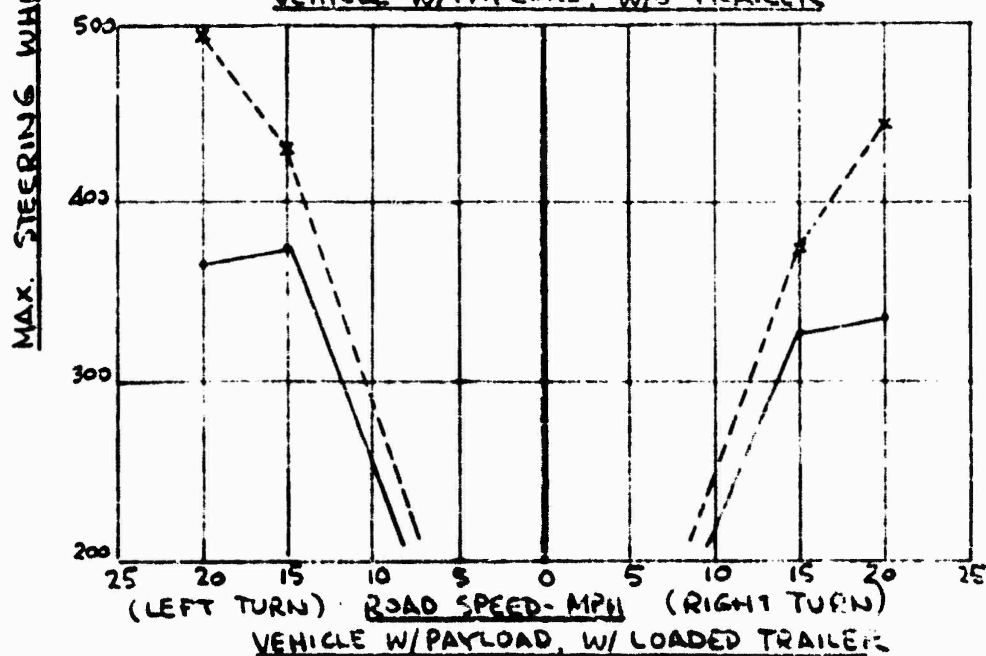
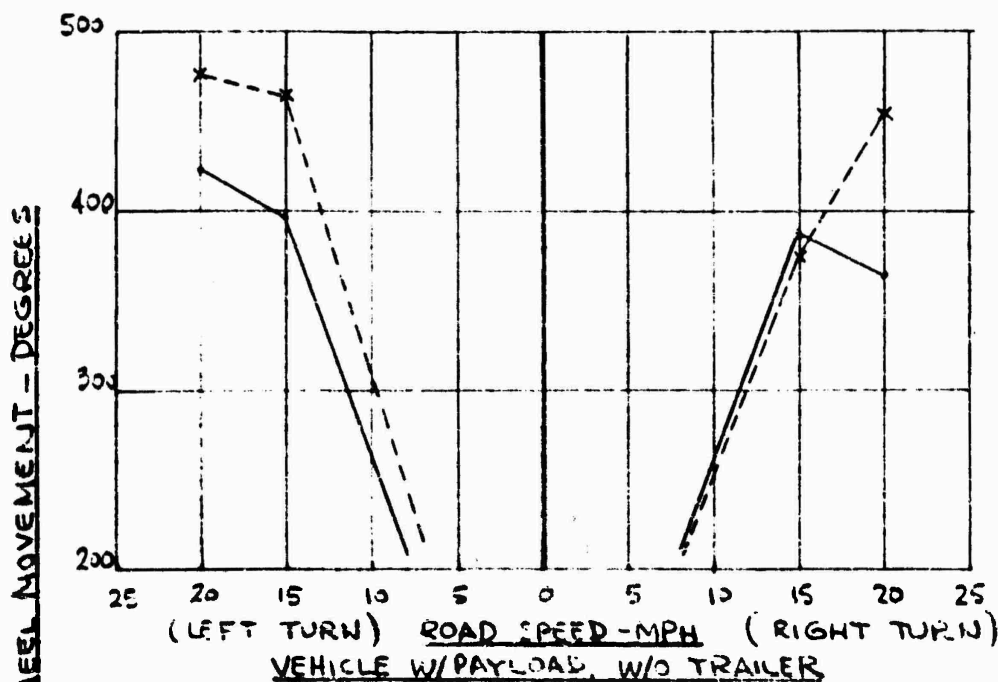
TRUCK, UTILITY: 1/4 TON, 4x4, M151, USA REG NO. 2E9033 & 2E2976

CURVES OF MAXIMUM STEERING WHEEL MOVEMENT WHILE CORNERING A 25 FT RADIUS CURVE AT STEADY SPEED - COMPARISON OF STANDARD AXLE (VEHICLE NO. 2E9033) AND SOLID AXLE (VEHICLE NO. 2E2976)

Test conditions: Vehicle w/ Pay Load; w/ & w/o Loaded Trailer

Dates of Test: 15-17 October 1965

Curve	Vehicle
.....	Standard Axle
-----x-----	Solid Axle



Truck, Utility: 1/4-Ton, 4X4, M151, USA Registration No. 2E9033 and  
2E2976

Driver's Name \_\_\_\_\_

Vehicle Load Conditions \_\_\_\_\_

Solid Axle	Standard Vehicle	Both Same
---------------	---------------------	--------------

1. Which truck had the fastest steering?  
(required the least wheel turning)
2. Which truck body leaned the most on  
curves and during steering maneuvers?
3. Which truck gave a better feeling of  
confidence and control during steering  
maneuvers?
4. Which truck required the most steering  
control while braking?
5. Which truck pitched forward more while  
braking?
6. Which truck had the best ride quality?
7. Which truck did you like driving best?
8. Which truck has the best cross-country  
mobility?

Indicate choice by marking the appropriate block.

Truck, Utility: 1/4-Ton, 4X4, M151, USA Registration No. 2E9033 and 2E2976

# Jury Voting Results on Chicane Course

Question No.	Abbrev Ques	Load Condition			
		Empty Without Trailer	Empty With Trailer	Loaded Without Trailer	Loaded With Trailer
1	Least wheel turning	Standard 2/1	Standard 3/1	Standard 3/1	Standard 3/1
2	Leaned more in turns	Same 3/3	Same 3/3	Same 3/3	Modified 4/2
3	Feeling of confidence and control <sup>a</sup>	Modified 5/1	Modified 6/0	Modified 4/2	Same 3/3
4	More steering control required in braking	No comparison this phase			
5	More forward pitch in braking	No comparison this phase			
6	Best ride quality	Standard 3/0	Standard 3/0	Standard 2/0	Standard 4/0
7	Liked best	Modified 3/1	Modified 5/1	Modified 3/1	Modified 3/1
8	Best cross-country mobility	-	-	-	-

<sup>a</sup>Votes for standard M151 on question No. 3 were often accompanied by the notation "It may be a false sense of confidence."

Note: "Both same" votes are not included in vote count.

Truck, Utility: 1/4-Ton, 4X4, M151, USA Registration Nos. 2E9033 and 2E2976

Jury Voting Results on Level Cross-Country Course

Question No.	Abbrev Ques	Load Condition			
		Empty Without Trailer	Empty With Trailer	Loaded Without Trailer	Loaded With Trailer
1	Least wheel turning	Standard 3/0	Standard 3/0	Standard 4/0	Standard 3/0
2	Leaned more in turns	Modified 4/1	Modified 3/0	Modified 4/0	Modified 5/0
3	Feeling of confidence and control	Same 3/3	Standard 6/0	Standard 6/0	Standard 6/0
4	More steering control required in braking	Standard 2/1	Modified 2/1	Modified 4/0	Modified 3/1
5	More forward pitch in braking	Standard 4/0	Standard 6/0	Standard 6/0	Standard 6/0
6	Best cross-country ride	Standard 6/0	Standard 6/0	Standard 6/0	Same 2/2
7	Liked best	Standard 4/2	Standard 6/0	Standard 6/0	Standard 5/1
8	Best cross-country mobility	-	Standard 4/0	Standard 5/0	Standard 4/0

Note: "Both same" votes are not included in vote count.

Truck, Utility: 1/4-Ton, 4X4, M151, USA Registration Nos. 2E9033 and 2E2976

Jury Voting Results on Hilly Cross-Country Course

Question No.	Abbrev Ques	Empty Without Trailer	Empty With Trailer	Loaded Without Trailer	Loaded With Trailer
1	Least wheel turning	Standard 5/0	Standard 4/0	Standard 6/0	Standard 6/0
2	Leaned more in turns	Modified 3/1	Modified 3/1	Modified 5/0	Modified 5/0
3	Feeling of confidence and control	Standard 6/0	Standard 6/0	Standard 6/0	Standard 6/0
4	More steering control required in braking	Same 1/1	Modified 3/0	Modified 4/1	Modified 4/1
5	More forward pitch in braking	Standard 6/0	Standard 6/0	Standard 6/0	Standard 6/0
6	Best ride quality	Standard 6/0	Standard 6/0	Standard 6/0	Standard 6/0
7	Liked best	Standard 6/0	Standard 6/0	Standard 6/0	Standard 6/0
8	Best cross-country mobility	Standard 6/0	Standard 5/0	Standard 6/0	Standard 6/0

Note: "Both same" votes are not included in vote count.

Truck, Utility: 1/4-Ton, 4X4, M151, USA Registration Nos. 2E9033 and 2E2976.

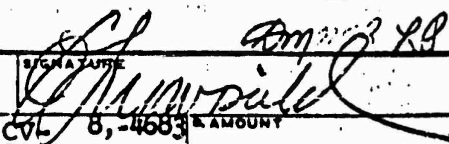
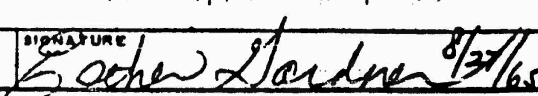
Jury Voting Results on Munson Course

Question No.	Abbrev Ques	Empty Without Trailer	Empty With Trailer	Loaded Without Trailer	Loaded With Trailer
1	Least wheel turning	Standard 4/0	Standard 4/0	Standard 4/0	Standard 4/0
2	Leaned more in turns	Modified 3/2	Modified 4/1	Modified 5/1	Modified 5/1
3	Feeling of confidence and control	Standard 4/2	Standard 5/1	Standard 6/1	Standard 6/1
4	More steering control required in braking	Standard 4/2	Standard 2/0	Modified 4/0	Modified 6/0
5	More forward pitch in braking	Standard 6/0	Standard 5/0	Standard 6/0	Standard 6/0
6	Best ride quality	Standard 6/0	Standard 6/0	Standard 6/0	Standard 3/1
7	Liked best	Same 3/3	Standard 5/1	Standard 6/0	Standard 6/0
8	Best cross-country mobility	-	Standard 4/0	Standard 5/0	Standard 4/0

Note: "Both same" votes are not included in vote count.



# APPENDIX II - CORRESPONDENCE

<b>PROJECT ORDER</b> (AR 33-264) (See Reverse Side for Instructions for Issuing Project Order)		1. <input type="checkbox"/> FIXED PRICE <input checked="" type="checkbox"/> COST REIMBURSEMENT	2. DATE 24 Aug 1965
ORDERING COMPONENT Project Manager General Purpose Vehicles		ADDRESS U.S. Army Mobility Command ATTN: AMCPM-GP-MPM Warren, Michigan 48090	4. PROJECT ORDER NO. GP0028 5. AMENDMENT NO. 01
PERFORMING ESTABLISHMENT NAME U. S. Army Test & Evaluation Command		ADDRESS Aberdeen Proving Ground ATTN: STEAP-DS-TU Aberdeen, Maryland	STATION NUMBER
7. DELIVERY INSTRUCTIONS PLACE DATE METHOD			
8. DESCRIPTION OF WORK TO BE PERFORMED AND OTHER INSTRUCTIONS (If Additional Space Is Required, Use Supplemental Data Section on Reverse Side Hereof or Attach Additional Sheets) PRON: 30-6-GP535-01-30-K2 AMCMS Code: 4510.04.3101 AMCMS Title: Truck, Utility, 1/4 Ton, 4x4, M151 Customer Order No. A1-6-13310-A1-30 1. The purpose of this project order is to provide Program and Funding Authority for testing of the solid rear axle for the M151 vehicle in accordance with the following test program: a. Phase A of test program (1) Determine a suitable test course that will provide cross section of various road conditions for adequate ride and handling evaluation. This test course can include segments of all the various test courses at APG (i.e., Perryman, Churchville and Munson), with sufficient mileage of each type to allow an adequate evaluation. This test course should include a Sine-Wave type maneuver on paved level road to evaluate rapid changes of direction of the vehicles. (2) At least six drivers should be considered as the jury team. The driver selection is to be at your discretion to obtain the most adequate evaluation of ride and handling characteristics of the vehicles with respect to correlation to actual driver skills expected in user operation.			
9. DATE ORDERED 24 Aug 65	TYPED NAME AND TITLE OF ORDERING OFFICER C. F. NOWOSIELSKI Chief, Prog Mgt Div, GPV		SIGNATURE 
10. ACCOUNTING CLASSIFICATION 21X2030 664-3000 P4510 20-113 AMCMS 4510.04.3101		11. THIS ORDER IS PLACED IN ACCORDANCE WITH THE PROVISIONS OF 41 USC 23, AND DEPARTMENT OF DEFENSE DIRECTIVE 7120.1. WORK TO BE PERFORMED AND MATERIAL TO BE PROCURED PURSUANT TO THIS ORDER ARE PROPERLY CHARGEABLE TO THE APPROPRIATION OR OTHER ACCOUNTS INDICATED ABOVE UNTIL 30 June 1967 (Day - Month - Year) THE EXPIRATION DATE OF THIS PROJECT ORDER. FUNDS IN THE AMOUNT INDICATED ABOVE HAVE BEEN COMMITTED AND WILL BE OBLIGATED UPON RECEIPT OF ACCEPTANCE COPY.	
TYPED NAME AND TITLE OF AUTHORIZING OFFICER ESTHER GARDNER, Deputy Fiscal Officer		SIGNATURE 	
12. THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.			
DATE ACCEPTED 8 SEP 1965	TYPED NAME AND TITLE OF ACCEPTING OFFICER INFORMATION		SIGNATURE

CONTINUATION OR SUPPORTING SHEET <small>(AMC REG 11-2)</small>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">PAGE</td> <td style="width: 50%; border-bottom: 1px solid black;">OF</td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="border-bottom: 1px solid black;">PRON 30-6-GP535- 01-30-K2</td> <td style="border-bottom: 1px solid black;">AMCHS CODE 4510-04-3101</td> </tr> </table>	PAGE	OF	2	2	PRON 30-6-GP535- 01-30-K2	AMCHS CODE 4510-04-3101
PAGE	OF						
2	2						
PRON 30-6-GP535- 01-30-K2	AMCHS CODE 4510-04-3101						

(3) The jury driver team should familiarize themselves prior to test with both vehicles.

b. Phase B

(1) The following cycles of the test course are to be run by each jury driver:

(a) Driver only

(b) Driver only with empty trailer

(c) Cross-country load

(d) Cross-country load with 1,500 pounds gross towed load.

(2) Vehicle speed of each test cycle for both vehicles is to be recorded.

(3) Steering wheel angle during each test cycle is to be recorded.

(4) Accelerometers are to be attached to the four extreme corners of the body to record lateral acceleration during the Sine-Wave test sequence.

(5) Each driver after running each test course will report on a check sheet, comment in respect to ride and handling of the particular vehicle. These reports are to be individual and should not reflect any discussion between drivers.

2. The test solid rear axle M151 has been shipped to APG and is a ride and handling type vehicle and not intended for durability. This office recommends the frequent inspection of suspension components during test for possible failures.

3. No interim reports are necessary but a final report will be required.

4. No standard M151 vehicle will be sent for this test with the plan that a facility vehicle at the APG installation will be available.

AD Accession No.  
Development and Proof Services, Aberdeen Proving Ground, Maryland  
Final Report of USATECOM Project No. 1-6-4030-11, Engineer Design Test of Truck,  
Utility, 1/4-Ton, 4x4, M151 (Ride and Handling Characteristics), December 1965  
RDT&E Project No. Not Available, Report No. DPS-1847  
Author W. S. Thompson  
Secondary distribution controlled by US Army Mobility Command, ATTN: AMCPM-GP-MPM  
44 pages, 20 illustrations

Unclassified Report

A test was conducted to compare the relative ride and handling characteristics of the standard M151 truck with those of an M151 truck incorporating a solid rear axle with single leaf semielliptical rear springs. A jury of six drivers performed comparison operations under various vehicle load conditions over specified test courses at Aberdeen Proving Ground, Md. Operation and data show stability of the solid-axle-equipped M151 vehicle to be more easily maintained by virtue of a tendency to slide on a paved surface, whereas the standard M151 tends to tuck the outer rear wheel under the body. This adversely affects stability in a manner not felt by the operator. On the other hand, the modified M151 truck had noorer ride characteristics on rough surfaces and less control on loose surfaces, thereby offering reduced mobility under tactical conditions.

AD Accession No.  
Development and Proof Services, Aberdeen Proving Ground, Maryland  
Final Report of USATECOM Project No. 1-6-4030-11, Engineer Design Test of Truck,  
Utility, 1/4-Ton, 4x4, M151 (Ride and Handling Characteristics), December 1965  
RDT&E Project No. Not Available, Report No. DPS-1847  
Author W. S. Thompson  
Secondary distribution controlled by US Army Mobility Command, ATTN: AMCPM-GP-MPM  
44 pages, 20 illustrations

Unclassified Report

A test was conducted to compare the relative ride and handling characteristics of the standard M151 truck with those of an M151 truck incorporating a solid rear axle with single leaf semielliptical rear springs. A jury of six drivers performed comparison operations under various vehicle load conditions over specified test courses at Aberdeen Proving Ground, Md. Operation and data show stability of the solid-axle-equipped M151 vehicle to be more easily maintained by virtue of a tendency to slide on a paved surface, whereas the standard M151 tends to tuck the outer rear wheel under the body. This adversely affects stability in a manner not felt by the operator. On the other hand, the modified M151 truck had noorer ride characteristics on rough surfaces and less control on loose surfaces, thereby offering reduced mobility under tactical conditions.



Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author)		2a. REPORT SECURITY CLASSIFICATION
Development and Proof Services Aberdeen Proving Ground, Maryland		Unclassified
		2b. GROUP
3. REPORT TITLE		
ENGINEER DESIGN TEST OF TRUCK, UTILITY, 1/4-TON, 4X4, M151 (RIDE AND HANDLING CHARACTERISTICS)		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)		
Final Report 13 through 26 October 1965		
5. AUTHOR(S) (Last name, first name, initial)		
Thompson, W. S.		
6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
December 1965	44	0
8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)	
Not applicable	DPS-1847	
b. PROJECT NO.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
USATECOM Project No. 1-6-4030-11		
c.		
d.		
10. AVAILABILITY/LIMITATION NOTICES		
US military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through US Army Mobility Command, ATTN: AMCPM-GP-MPM.		
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY
None		USAMOCOM
13. ABSTRACT		
<p>A test was conducted to compare the relative ride and handling characteristics of the standard M151 truck with those of an M151 truck incorporating a solid rear axle with single leaf semielliptical rear springs. The test was conducted from 24 August to 17 October 1965. A jury of six drivers performed comparison operations under various vehicle load conditions over specified test courses at Aberdeen Proving Ground, Maryland. Chicane<sup>a</sup> course operation was augmented by instrumentation measuring steering wheel angle, true road speed, road wheel dynamic deflections, and lateral acceleration. After executing severe turning maneuvers on paved surfaces, driver preference was 5 to 1 for the solid-axle-equipped M151 truck; however, after operation on the cross-country courses, driver preference was 6 to 0 for the standard M151 truck. Operation and data show stability of the solid-axle-equipped M151 vehicle to be more easily maintained by virtue of a tendency to slide out on a paved surface, whereas the standard M151 tends to tuck the outer rear wheel under the body. This adversely affects stability in a manner not felt by the operator. On the other hand, the modified M151 truck had poorer ride characteristics on rough surfaces and less control on loose surfaces, thereby offering reduced mobility under tactical conditions.</p> <p><sup>a</sup>Chicane is the industry terminology for a steering effort course such as the sine-wave path shown in Appendix I-1.</p>		

DD FORM 1473  
1 JAN 64

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

## INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. **REPORT SECURITY CLASSIFICATION:** Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. **GROUP:** Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. **REPORT TITLE:** Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. **DESCRIPTIVE NOTES:** If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. **AUTHOR(S):** Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. **REPORT DATE:** Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. **TOTAL NUMBER OF PAGES:** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. **NUMBER OF REFERENCES:** Enter the total number of references cited in the report.

8a. **CONTRACT OR GRANT NUMBER:** If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. **PROJECT NUMBER:** Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. **ORIGINATOR'S REPORT NUMBER(S):** Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. **OTHER REPORT NUMBER(S):** If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. **AVAILABILITY/LIMITATION NOTICES:** Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through \_\_\_\_\_."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through \_\_\_\_\_."
- (5) "All distribution of this report is controlled. Qualified DEC users shall request through \_\_\_\_\_."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. **SUPPLEMENTARY NOTES:** Use for additional explanatory notes.

12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. **ABSTRACT:** Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

**SUPPLEMENTARY**

**INFORMATION**



DEPARTMENT OF THE ARMY  
ABERDEEN PROV'NG GROUND HFIvins/jc/3080  
ABERDEEN PROVING GROUND, MARYLAND 21075

STEAP-DS-DE

29 December 1965

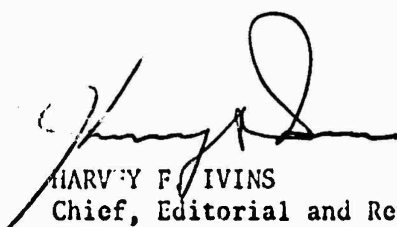
SUBJECT: Correction on USATECOM Project No. 1-6-4030-11, Engineer Design  
Test of Truck, Utility, 1/4-Ton, 4X4, M151 (Ride and Handling  
Characteristics), Report No. DPS-1847

TO: See Report Distribution

Insert corrected pages 1 and 2 in copies of subject report now  
in your possession.

FOR THE COMMANDER:

1 Incl  
as

  
HARVEY F. IVINS  
Chief, Editorial and Reports



ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 1-6-4030-11

FINAL REPORT OF ENGINEER DESIGN TEST OF TRUCK,

UTILITY, 1/4-TON, 4X4, M151 (RIDE AND

HANDLING CHARACTERISTICS)

13 THROUGH 26 OCTOBER 1965

### SECTION 1. GENERAL

#### 1.1 OBJECTIVE

This test was conducted to evaluate the ride and handling characteristics of a modified M151 truck equipped with single-leaf semielliptical rear springs and a solid rear axle by comparison with a standard M151 truck.

#### 1.2 RESPONSIBILITIES

Not applicable.

#### 1.3 DESCRIPTION OF MATERIAL

The test vehicle was a production model truck, utility, 1/4-ton, 4X4, M151 which was modified to incorporate a solid rear axle suspended by two single-leaf semielliptical rear springs (Figure 1). Two cross-pin type front shock absorbers were used. These had standard operating lengths and 1/2-inch extended compressed lengths. The front coil springs were nonstandard, having spring rates of 627 pounds per inch (standard spring rate is 513 pounds per inch). The USA registration number of this vehicle is 2E2976 and is identified in this report as the modified vehicle.

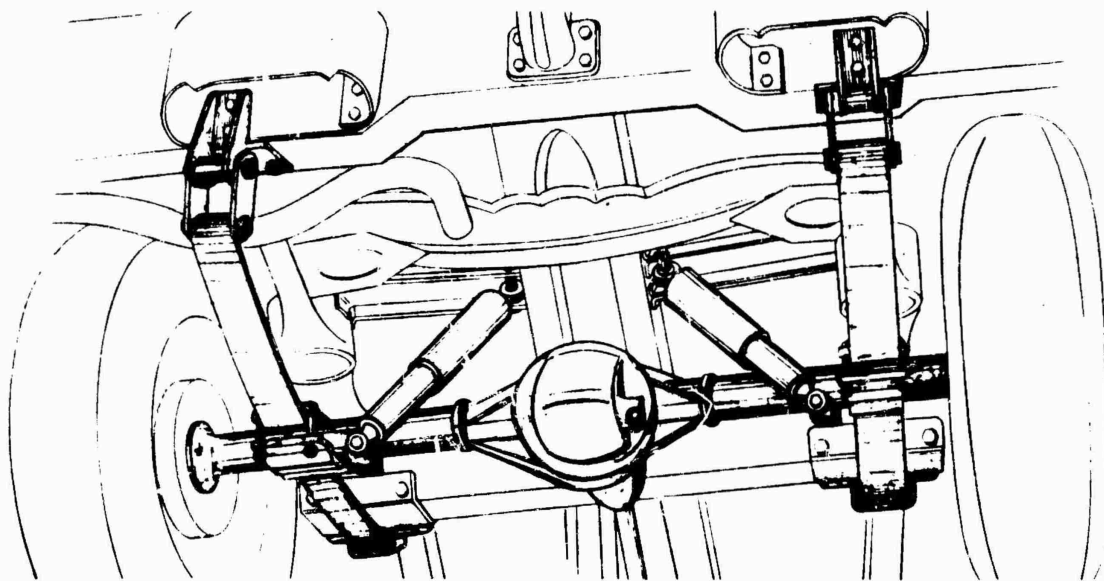


Figure 1: Modified M151 With Solid Rear Axle (View from Rear Looking Forward).

The comparison vehicle was a standard 1/4-ton utility truck, 4X4, M151, with confirmed serviceable shock absorbers and other rear independent suspension components (Figure 2). New tires were installed prior to testing. The USA registration number of this vehicle is 2E9033 and is identified in this report as the standard vehicle.

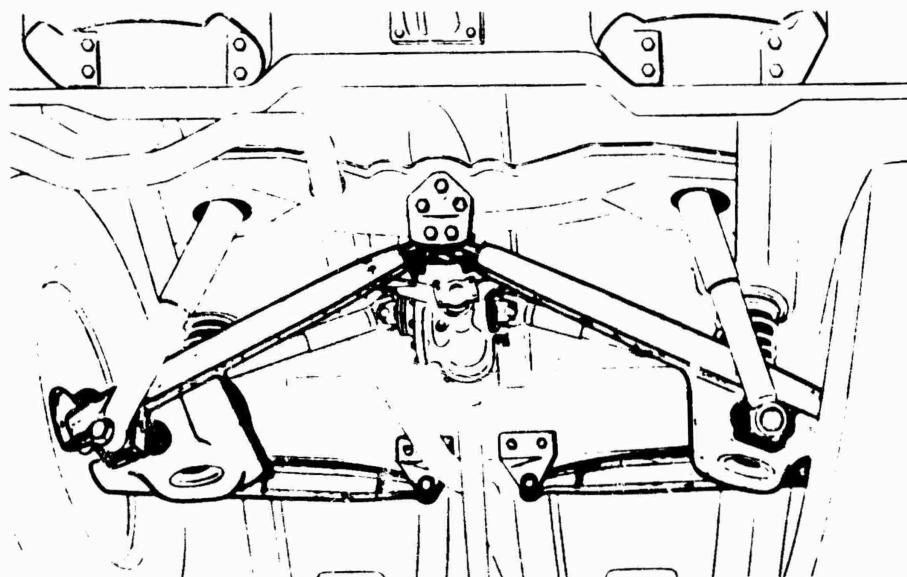


Figure 2: M151, 1/4-Ton (View from Rear Looking Forward).



REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
PROGRAM EXECUTIVE OFFICE  
COMBAT SUPPORT & COMBAT SERVICE SUPPORT  
6501 EAST 11 MILE ROAD  
WARREN, MICHIGAN 48397-5000

SFAE-CSS

22 MAR 2013

MEMORANDUM FOR Defense Technical Information Center (DTIC-OQ), 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218

SUBJECT: Change of Classification Level to 4M151 Truck Documents

1. Reference Defense Technical Information Center (DTIC) Infosec "RE: M151A2 Documents retrieval and review" direction email of 14 December 2012.
2. In accordance with the above reference, please change the classification and distribution level for the following documents:
  - a. Document.
    - (1) The DTIC AD#: ADB271644
    - (2) Title: M151 Transmission Clutch Hub Insert – P/N 7059129
    - (3) Date of Document: 29 February 1972
    - (4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.
    - (5) Reason for Change: This document has been reviewed for Operations Security (OPSEC) and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.
    - (6) Date of Change: Immediately

b. Document 2.

- (1) The DTIC AD#: AD0474825
- (2) Title: ENGINEER DESIGN TEST OF TRUCK, UTILITY, 1/4-TON, 4X4, M151 (RIDE AND HANDLING CHARACTERISTICS)
- (3) Date of Document: 15 December 1965

SFAE-CSS

SUBJECT: Change of Classification Level to 4M151 Truck Documents

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

c. Document 3.

(1) The DTIC AD#: AD0857240

(2) Title: Product Improvement Test of Truck, Utility, 1/4-TON, 4X4, M151 Series with Modified Independent Rear Suspension System

(3) Date of Document: 27 June 1969

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

d. Document 4.

(1) The DTIC AD#: ADB273320

(2) Title: Bonded vs. Riveted Brake Lining Test

(3) Date of Document: 12 January 1977

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

SFAE-CSS

SUBJECT: Change of Classification Level to 4M151 Truck Documents

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

e. Document 5.

(1) The DTIC AD#: AD0810372

(2) Title: Product Improvement Test of Truck, Utility, 1/4-TON, 4X4, M151 Modified with Solid Rear Axle

(3) Date of Document: March 1967

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

f. Document 6.

(1) The DTIC AD#: ADB271624

(2) Title: Transmission Cluster Gear (M151 Vehicle)

(3) Date of Document: 06 March 1972

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

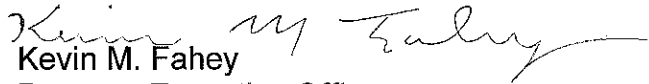
(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

SFAE-CSS

SUBJECT: Change of Classification Level to 4M151 Truck Documents

(6) Date of Change: Immediately

3. The Point of Contact for this action is Robert Anick, Sr, email:  
robert.d.anick.civ@mail.mil or COM (586) 282-8448.

  
Kevin M. Fahey  
Program Executive Officer,  
Combat Support & Combat Service Support